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(19)

(54) PROCESS FOR THE PRODUCTION OF CRIMPED SYNTHETIC STRANDS AND CRIMPED STRANDS OBTAINED THEREBY

(71) We, SNAM PROGETTI S.p.A., an Italian Company, of Corso Venezia, 16, Milan, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of crimped synthetic strands, and to the crimped strands obtained thereby.

The production of crimped synthetic strands is important in the manufacture of textile articles, in particular carpets and moquettes.

The crimped synthetic strands must have a uniform crimp to ensure a uniform appearance but the crimp must not be excessive otherwise the weaving operation, known in the art as tufting, is difficult. On the other hand, if the crimp is too low, in order to have a good covering, the carpet would have to be very heavy.

Furthermore, high quality carpets have to be manufactured from a strand formed of filaments having a non-circular cross-section because these ensure that the carpet is more brilliant, with less dull colours, and masks more dirtiness. The non-circular cross-section also increases the covering power.

The strand for carpets must not be too crimped before tufting; it must increase its crimping during the dyeing of the piece.

The process for producing the initial crimp should ensure a substantially uniform crimp, i.e. a constant number of crimps and crimping rate (as hereinafter defined), even with a slight variation in the working conditions, and must prevent any significant deformation of the shape of the cross-section of the filaments.

Many processes for the production of crimped strands are known. They are based essentially on the so-called method of crimping by compression. Here, a strand withdrawn from a bobbin is drawn and then passed through calender rolls which push it into a chamber wherein it is compressed by being forced against a load positioned in the chamber. The strand is in this way subjected to a combined bending and compressive stress and so acquires the necessary crimp. Then the strand is wound on a bobbin.

After tufting the strand is subjected to dyeing by being boiled. In general, the known processes are not suitable to produce crimped strands having all the aforementioned characteristics. In particular the crimped strands obtained according to the known art do not have a uniform crimp and this, as mentioned above, affects the covering power of the strand and the uniformity of dyeing; furthermore the strand, especially in some processes wherein it is heated before being fed to the compression chamber, possesses significant deformations of its cross-section with a consequent significant decrease in its brilliance.

According to the present invention, there is provided a method for the production of a crimped synthetic strand, which method comprises drawing the strand to effect molecular orientation, feeding the drawn strand to a compression chamber wherein crimping is effected, subjecting the strand to a vapour or a gas-vapour mixture at a temperature in the range from 70°C to 150°C either during the crimping or subsequent to the crimping, then reducing or eliminating the visible crimps in the strand by drawing the strand, and collecting the resultant strand containing non-visible crimps.

One embodiment of the process according to the present invention comprises the following steps:

(a) withdrawing yarns, each formed of a plurality of filaments, from bobbins, and combining the yarns in order to form a strand having a suitable count;

(b) drawing the resulting strand until it has molecular orientation is effected, which affects, for example, the tensile strength;

(c) passing the drawn strand through a device, in particular calender rolls, which

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feeds it to a compression chamber provided with a suitable load against which the strand can bear, thereby acquiring the necessary crimp;

(d) withdrawing the strand from the crimping chamber and treating it in a subsequent zone with a vapour either fed from outside or produced in situ; the vapour fed from outside can be saturated, superheated or in a gaseous mixture, in particular air; the amount of gas in the gas-vapour mixture can be up to 80% by weight of the total mixture; alternatively, the vapour produced in situ can be produced by vaporization (either with hot gases or with other suitable media) of the liquid present or contained in the strand when it is introduced wet to the treatments of steps (a), (b) and (c); the vapour or the gases fed from outside are introduced through suitable distributors at suitable points in the zone;

(e) withdrawing the crimped strand from the zone of step (d) and feeding the same, after passage on suitable thread tension devices, to a system for reducing or eliminating the visible crimp, constituted by a set of rollers and a heated plate; and

(f) withdrawing the strand from the system of step (e) and collecting the withdrawn strand on a suitable collecting device.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawing which shows schematically an apparatus suitable for carrying out the method of the present invention.

In the apparatus there are shown bobbins 1, 2 and 3 from which yarns are withdrawn. The withdrawn yarns are passed through a collecting ring 4 and the resulting strand is fed to a drawing system which includes a godet 5, a heated drawing plate 6, and a godet 7 for drawing off the drawn strand. The drawn strand is fed through calender rolls 8 to a compression chamber 9 wherein the crimp is effected. In the chamber 9 is a flap 10 which exerts pressure on the strand entering the chamber. The compressed strand is fed to a chamber 11 whereto vapour is fed according to the invention. Then the strand is passed through a group of thread tensioners 12, around suitable transmission rollers 13, 14, to the system for eliminating visible crimps, which system includes rollers 15, 17 and a heated plate 16. Finally the strand is collected on a collecting bobbin 18.

The process of the present invention is suitable for use with strands formed of synthetic polymers, in particular polyamides such as Nylon 6 and Nylon 6,6.

It is important to note that the vapour or the gas-vapour mixture can be fed either to the compression chamber 9 or to the chamber 11.

The amount of vapour present is preferably higher than 0.04 kg per kg of strand.

The temperature in the chamber 9 or the chamber 11 wherein the vapour or the gas-vapour mixture is present is in the range of from 70°C to 150°C.

The strand obtained according to the process of the present invention preferably has, before dyeing, a crimp with a number of crimps per centimetre in the range of from 2 to 8; preferably it has a rate of from 5% to 25% wherein the rate is defined by the following formula:

$$\text{rate } \% = 100 \times \left\{ 1 - \frac{\text{length of the crimped strand}}{\begin{array}{c}\text{length of the strand under a tension sufficient}\\ \text{to eliminate all visual crimp in the strand}\end{array}} \right\}$$

The rate increase, expressed as a percentage of the initial rate, is preferably higher than 10%, more preferably about 100%.

The following Examples will now be given to illustrate the present invention.

Example 1

A Nylon 6 filament, which had a relative viscosity of 2.9 in a 1% solution in 96.4% sulphuric acid at a temperature of 20°C, was spun in order to produce a yarn made up of 50 filaments having a trilobal cross-section, the total count being 2600 den.

The yarn was oiled during spinning with a standard oil (Lukanol M: sold by Schill and Seilacher) in a standard concentration (8 g per litre of water). The yarns were treated in an apparatus of the type illustrated in the accompanying drawing.

Three bobbins of yarn having the aforementioned characteristics were used in order to form a single strand, which was drawn over a drawing plate with a drawing ratio of 3.8 and a feed rate of 90 m/min, the temperature of the drawing plate being 120°C. The drawn strand was fed to a compression chamber which had a rectangular cross-section of 6×16 mm and in which the crimping load was 490 g.

In a subsequent zone, steam, withdrawn from a pipe network at 3 atmospheres absolute, was fed into the chamber at a rate of 0.8 kg/hour. Then the strand was fed to the system for eliminating visible crimp in

which the drawing ratio was 1.30 and the temperature of the heated plate 16 was 130°C.

The resulting strand was characterised by a crimp with a frequency of 3 crimps per centimetre and a crimping rate of 11%. This strand was placed in boiling water for 30 minutes without tension, and then dried.

After this last treatment, the strand was characterised by a crimp with a frequency of 3.5 crimps per centimetre and a rate of 24%.

For control purposes, the foregoing procedure was carried out with a fresh strand, except the steam treatment was omitted. The resulting strand was characterised, prior to the boiling water treatment, by a crimp with a frequency of 3.2 crimps per centimetre and a rate of 10%. This strand was then subjected to the aforesaid treatment in boiling water, after which it had a frequency of 3.4 crimps per centimetre and a rate of 13%.

The cross-sections of the filaments of both strands were examined under high magnification but were found to be similar to that of a non-drawn filament, i.e. without any deformation.

Tufted carpets were manufactured under the same conditions from both treated strands, after having imparted to the latter 30 twists per metre. The workability was good for both carpets, but the carpet manufactured with the second strand (control) had a less regular appearance and an insufficient covering power; while that made from the first strand (obtained according to the invention) had a uniform appearance and very good covering power. The tenacity of the strands was in both cases the same and equal to 4.1 g/dn; the elongation was equally the same in both cases, namely 60%.

Examples 2—8

In these seven Examples the strands were obtained by working as in that embodiment of Example 1 according to the present invention (i.e. with steam treatment), but one of the variables was changed, as can be seen from the following Table 1.

TABLE 1

Example	Changed variable	Variation
2	load	190 g
3	load	700 g
4	steam	0.4 kg/h
5	steam	1.6 kg/h
6	second drawing ratio (in system 15—17)	1.16
7	temperature of the plate 16	150°C
8	oiling concentration	50% of the standard value

In the following Table 2 there are reported the analytical data found for the strands before and after boiling.

TABLE 2

Examples	Strand prior to boiling Crimps/cm	Strand prior to boiling Rate %	Strand after boiling Crimps/cm	Strand after boiling Rate %
2	2.8	9	3.1	23
3	4.1	18	3.2	25
4	3.0	12	3.2	24
5	3.3	10	3.3	24
6	3.4	20	3.2	26
7	3.1	9	3.0	23
8	3.0	13	3.8	26

These strands as well as the strand of Example 1 were utilised for manufacturing tufted carpets and no significant difference was noticed both in the covering power and in the appearance regularity.

Therefore the system working with a steam

feed had no apparent critical factors with regard to its variables.

For the sake of comparison, the procedures of Examples 2, 3, 6, 7 and 8 were carried out but without steam treatment. The analytical results are reported in the following Table 3.

TABLE 3

Examples	Strand prior to boiling Crimps/cm	Rate %	Strand after boiling Crimps/cm	Rate %
2A	3.0	9	3.0	10
3A	4.2	16	4.1	14
6A	4.2	18	4.0	20
7A	4.0	15	4.0	17
8A	4.0	13	4.0	13

Also some tufted carpets were manufactured from these strands. After dyeing, these carpets showed less covering power and this is in accordance with the smaller rate of the boiled strand; furthermore the carpets manufactured either with different strands or with the same strand showed great differences in appearance. The tenacity of the strands obtained in the single tests was comprised between 4.0 and 4.5 g/den and the ultimate elongations ranged from 55% to 65%.

Example 9

By working according to Example 1, but with strands formed from yarns constituted by filaments having a circular cross-section, and with an initial drawing ratio of 4.0, the finished strand (prior to boiling) had a tenacity of 4.7 g/den, an elongation of 58%, a crimp frequency of 2.8 crimps/cm and a rate of 8%.

After boiling, the strand had a frequency of 3.0 crimps/cm and a rate of 18%. In the absence of the steam treatment, a control strand (prior to boiling) had the same tenacity and elongation, but the crimp had a frequency of 3.0 crimps/cm and the strand had a rate of 9%. After treatment with boiling water as described in Example 1, the control strand had a crimp with a frequency of 3.0 crimps/cm and a rate of 11%. The tufted carpet manufactured with the first strand of this Example and then dyed had a covering power remarkably higher than that manufactured with the second strand of this Example.

Example 10

A Nylon 6.6 filament having a relative viscosity of 2.7 (as determined under the conditions specified in Example 1) was spun so as to produce a yarn comprising 50 filaments having a trilobal cross-section, the total count being 2600 den. Three bobbins of this yarn were used in an apparatus of the type previously described.

The strand was initially drawn with a drawing ratio of 4.2, the plate temperature being 140°C. The crimping chamber had a rectangular cross-section (6 mm×16 mm) and the crimping load was 490 g. The steam rate was regulated at 0.8 kg/h. In the system for eliminating visible crimping, the drawing ratio used was 1.30, and the temperature of the plate 16 was 170°C.

The strand obtained had, prior to boiling, a crimp with a frequency of 4.9 crimps/centimetre and a rate of 10%; it had, moreover, a tenacity of 3.5 g/den and an ultimate elongation of 62%.

After boiling, there were 4.2 crimps per centimetre and the rate was raised to 20%.

The tufted carpet manufactured from this strand after dyeing had a good covering power and good regularity of appearance.

WHAT WE CLAIM IS:—

1. A method for the production of a crimped synthetic strand, which method comprises drawing the strand to effect molecular orientation, feeding the drawn strand to a compression chamber wherein crimping is effected, subjecting the strand to a vapour or a gas-vapour mixture at a temperature in the range from 70°C to 150°C either during the crimping or subsequent to the crimping, then reducing or eliminating the visible crimps in the strand by drawing the strand, and collecting the resultant strand containing non-visible crimps.

2. A method according to Claim 1, wherein the vapour is provided from an outside source.

3. A method according to Claim 1 or 2, wherein the vapour is saturated.

4. A method according to Claim 1 or 2, wherein the vapour is superheated.

5. A method according to Claim 1, wherein the gas-vapour mixture is provided from an outside source.

6. A method according to Claim 5, wherein the amount of gas present in the gas-vapour mixture is up to 80% by weight of the total mixture.

7. A method according to Claim 1, wherein the vapour is generated in situ by vaporizing a liquid carried by the strand.

8. A method according to Claim 7, wherein the liquid is vapourized by subjecting the strand to a hot gas.

9. A method according to any preceding claim, wherein the vapour is steam.

10. A method according to any preceding claim, wherein the vapour is present in an amount of at least 0.04 kg per kg of strand.

11. A method according to any preceding claim, wherein the strand is formed from a plurality of yarns each formed from a plurality of filaments having a non-circular cross-section.

12. A method according to any preceding claim, wherein the drawn strand is fed to the compression chamber through calender rolls.

13. A method according to any preceding claim, wherein the strand is formed of nylon 6 or nylon 6,6.

14. A method according to Claim 1, substantially as described in any one of the foregoing Examples.

15. Crimped strand whenever obtained by a method according to any preceding claim.

16. Crimped strand as claimed in Claim 15, having from 2 to 8 crimps per centimetre and a rate (as hereinbefore defined) of from 5 to 25%.

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1352624 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*